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Piper

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(54) **DIGITAL LIGHTING SUB-NETWORK INTERFACE**

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H05B 37/00 (2006.01)
H05B 37/02 (2006.01)

(52) **U.S. Cl.**
CPC ***H05B 37/02*** (2013.01); ***H05B 37/0254*** (2013.01)

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CPC H05B 33/0842; H05B 37/02; H05B 37/0254; H05B 37/0272; H05B 41/36
USPC 315/312–321
See application file for complete search history.

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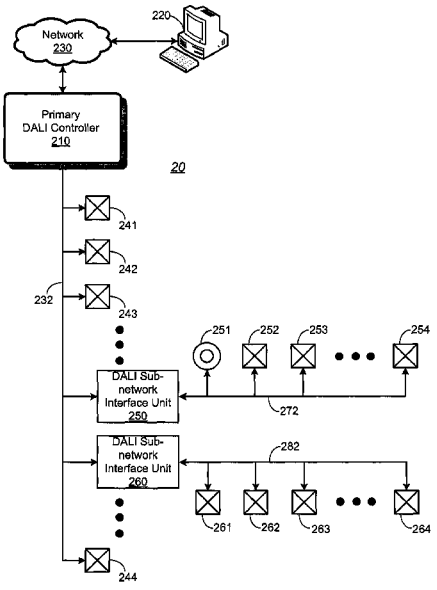
(57) **ABSTRACT**

A digital sub-network interface unit includes a primary digital lighting interface port to couple to a primary lighting network. An address of the digital sub-network interface unit on the primary lighting network is manually set at the digital sub-network interface unit. The digital sub-network interface unit also includes a secondary digital lighting interface port to couple to a secondary lighting network. The digital sub-network interface unit further includes a lighting sub-network processor. The lighting sub-network processor is configured to assign addresses to a plurality of secondary lighting fixtures, and to receive commands from a primary digital lighting controller in association with an address of the digital sub-network interface unit. The lighting sub-network processor is also configured to control a plurality of secondary lighting fixtures based on the commands received from the primary digital lighting controller.

20 Claims, 4 Drawing Sheets



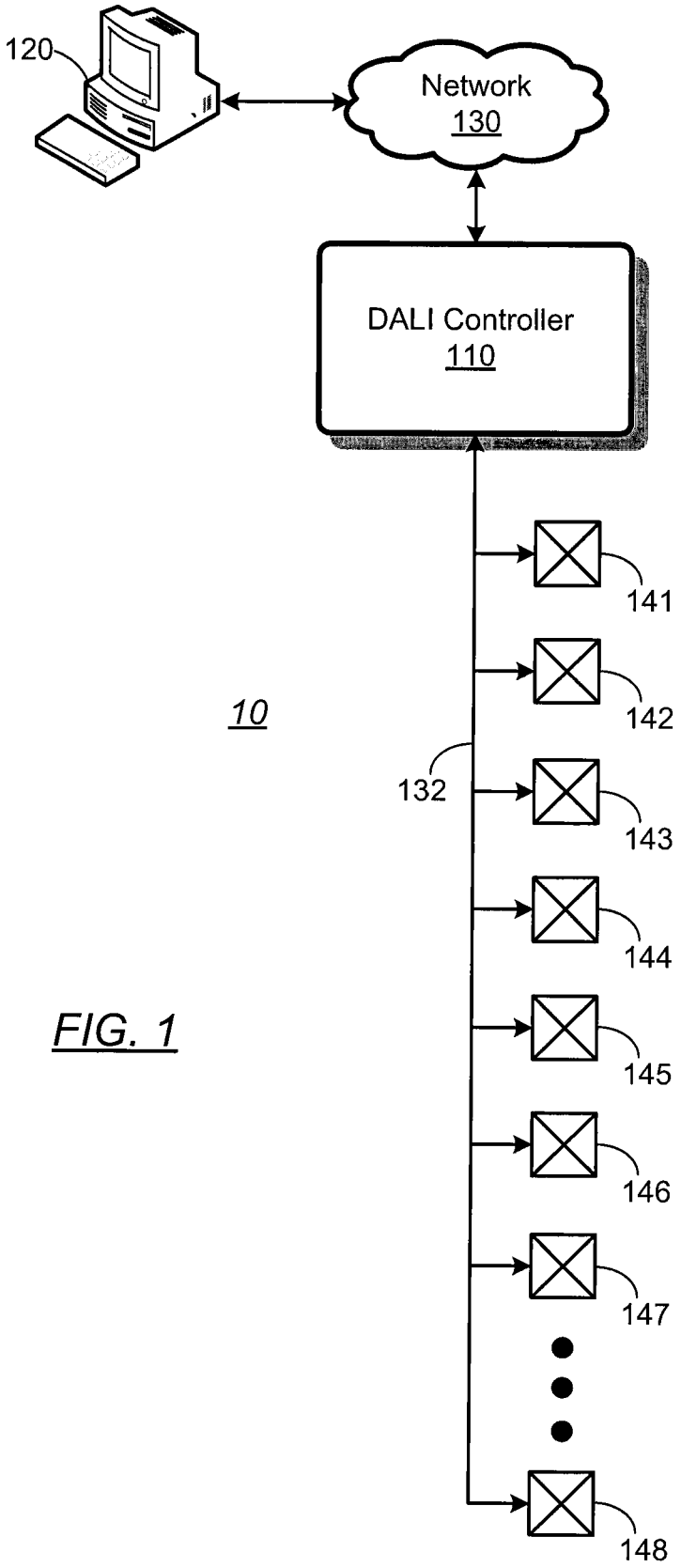

120
Network
130
DALI Controller
110
10
132
141
142
143
144
145
146
147
148

FIG. 1

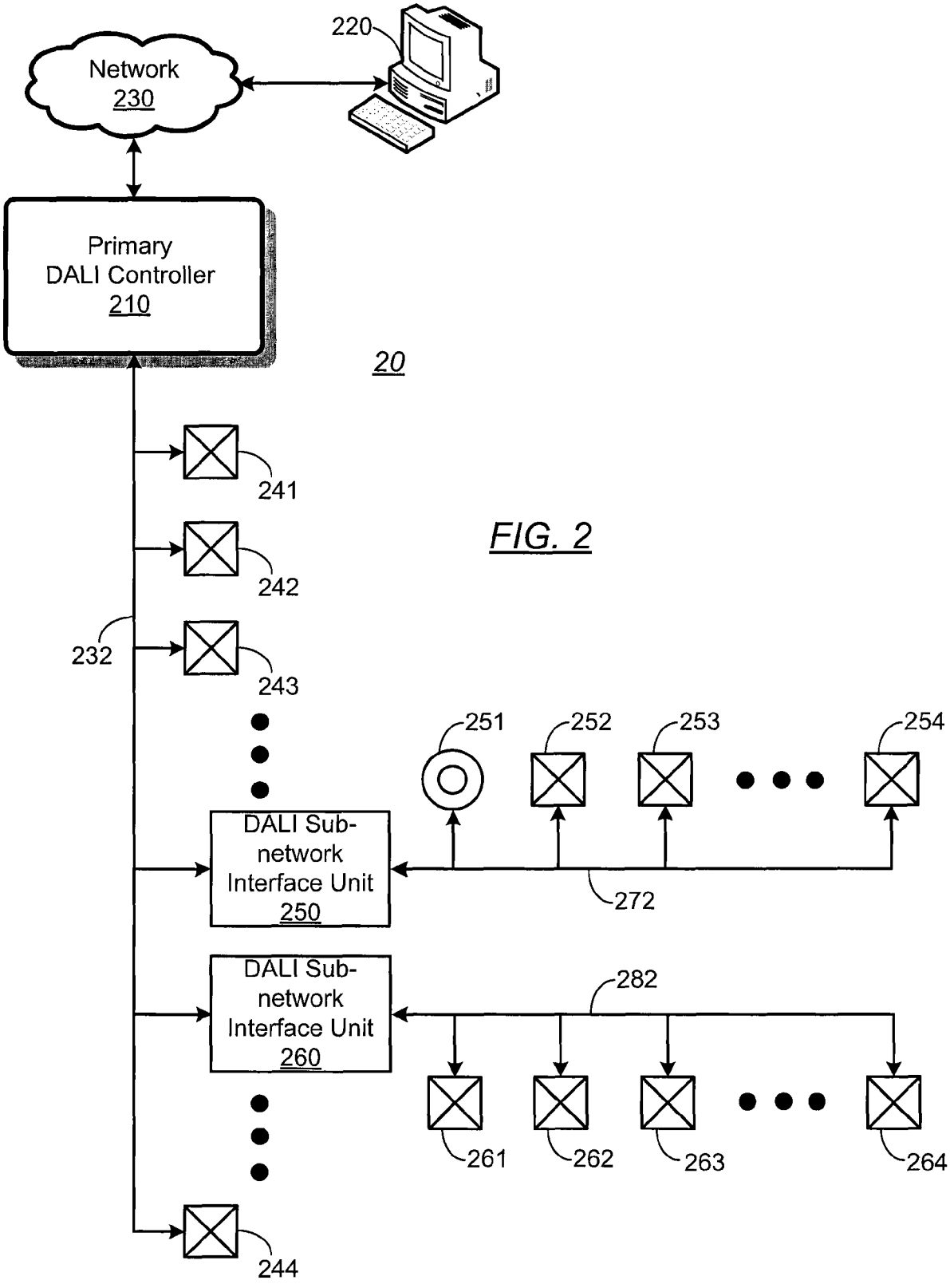

220
Network
230
Primary
DALI Controller
210
20
241
242
232
243
251
252
253
254
DALI Sub-
network
Interface Unit
250
272
DALI Sub-
network
Interface Unit
260
282
261
262
263
264
244

FIG. 2

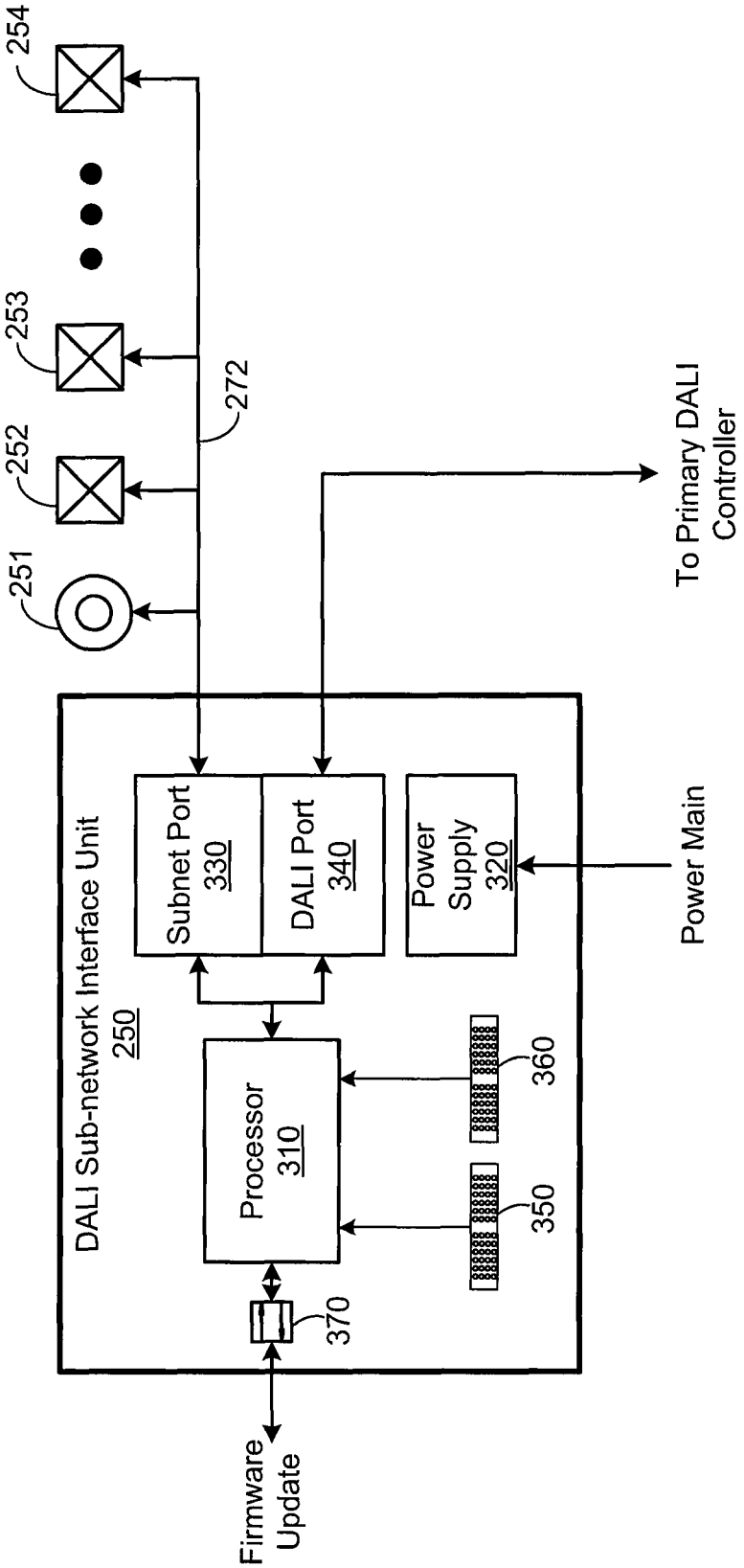

254
253
252
251
272
To Primary DALI Controller
DALI Sub-network Interface Unit
250
Subnet Port 330
DALI Port 340
Power Supply 320
Power Main
Processor 310
360
350
370
Firmware Update

FIG. 3

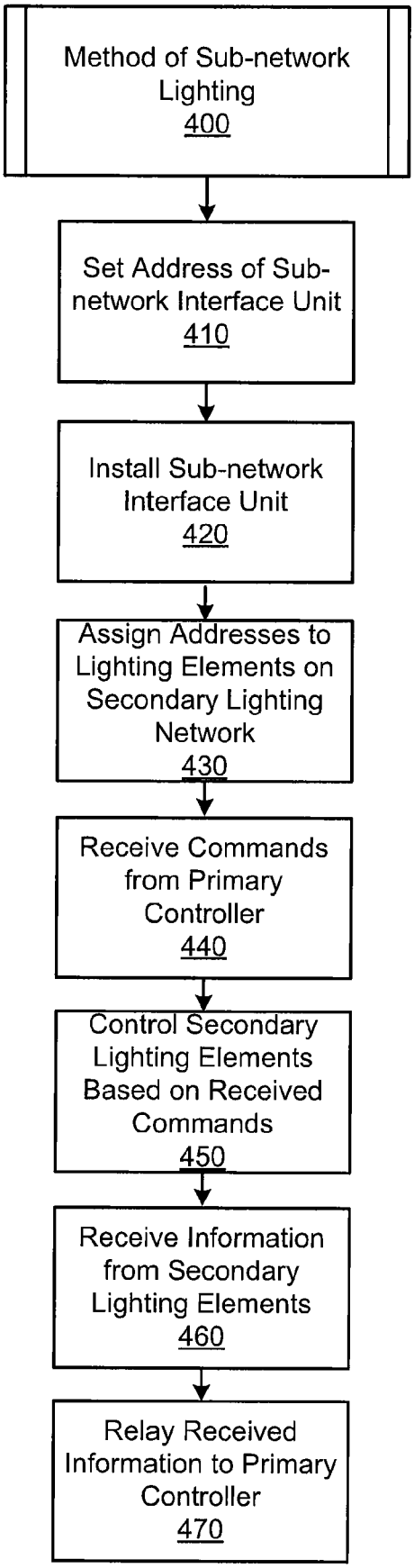

Method of Sub-network Lighting
400
Set Address of Sub-network Interface Unit
410
Install Sub-network Interface Unit
420
Assign Addresses to Lighting Elements on Secondary Lighting Network
430
Receive Commands from Primary Controller
440
Control Secondary Lighting Elements Based on Received Commands
450
Receive Information from Secondary Lighting Elements
460
Relay Received Information to Primary Controller
470

FIG. 4

DIGITAL LIGHTING SUB-NETWORK INTERFACE

RELATED APPLICATIONS

The present application claims priority to U.S. Provisional Patent Application No. 61/614,793, filed Mar. 23, 2012, and titled "Digital Lighting Sub-Network Interface," the entire content of which is incorporated herein by reference.

TECHNICAL FIELD

The present disclosure relates generally to control of lighting fixtures and more particularly to systems, methods, and devices for creating and operating a sub-network on a Digital Addressable Lighting Interface (DALI) lighting control network system.

BACKGROUND

A Digital Addressable Lighting Interface (DALI) network system typically includes a number of lighting fixtures that are attached to a network. A control device that is also attached to the network controls the lighting fixtures. The control device is also generally limited to a control over a particular maximum number of lighting fixtures that are attached to the network. If more than the maximum number of lighting fixtures need to be connected to the network, a separate second network with its own control device is typically required. The lighting fixtures in excess of the maximum number of lighting fixtures directly supportable by the first control device would typically be attached to the second network that has the second control device attached to it.

Further, the control device typically assigns addresses to the lighting fixtures after the lighting fixtures are installed on the network. Thus, identifying individual installed lighting fixtures or groups of lighting fixtures based on addresses assigned by the control device may be time consuming, particularly when a large number of lighting fixtures are installed on a network and/or when the control device assigns the addresses independently of relevant user input.

A device that is relatively easy to install and that enables extending the number of lighting fixtures beyond the maximum number of lighting fixtures that are directly supportable by a control device is desirable. Further, a device that facilitates identification of installed individual light fixtures and groups of lighting fixtures is also desirable.

BRIEF DESCRIPTION OF THE DRAWINGS

Reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

FIG. **1** presents a system illustrating an example operating environment for an example Digital Addressable Lighting Interface (DALI) network lighting control system according to one example embodiment;

FIG. **2** presents a system illustrating an example operating environment for an example digital sub-network lighting system in an example DALI network lighting control system according to one example embodiment;

FIG. **3** is a schematic diagram of an example DALI sub-network interface unit according to one an embodiment; and

FIG. **4** presents a flowchart of an example method for an operation of an example sub-network lighting system according to one example embodiment.

The drawings illustrate only example embodiments and are therefore not to be considered limiting in scope. The elements and features shown in the drawings are not necessarily to scale, emphasis instead being placed upon clearly illustrating the principles of the example embodiments. Additionally, certain dimensions or placements may be exaggerated to help visually convey such principles. In the drawings, reference numerals designate like or corresponding, but not necessarily identical, elements.

SUMMARY

The present disclosure relates to systems, methods, and devices for creating and operating a sub-network on a Digital Addressable Lighting Interface (DALI) lighting control network system. In an example embodiment, a digital sub-network interface unit includes a primary digital lighting interface port to couple to a primary lighting network. An address of the digital sub-network interface unit on the primary lighting network is manually set at the digital sub-network interface unit. The digital sub-network interface unit also includes a secondary digital lighting interface port to couple to a secondary lighting network. The digital sub-network interface unit further includes a lighting sub-network processor. The lighting sub-network processor is configured to assign addresses to a plurality of secondary lighting fixtures, and to receive commands from a primary digital lighting controller in association with an address of the digital sub-network interface unit. The lighting sub-network processor is also configured to control a plurality of secondary lighting fixtures based on the received commands from the primary digital lighting controller.

In another example embodiment, a digital sub-network lighting system includes a plurality of primary lighting fixtures communicably coupled to a primary lighting network. The digital sub-network lighting system also includes a primary digital lighting controller communicably coupled to the plurality of primary lighting fixtures and configured to assign addresses to the plurality of primary lighting fixtures. The digital sub-network lighting system further includes a sub-network lighting controller communicably coupled to the primary lighting network and to a secondary lighting network. An address of the sub-network lighting controller on the primary lighting network is manually set at the sub-network lighting controller. The sub-network lighting controller is configured to assign addresses to a plurality of secondary lighting fixtures on the secondary lighting network and to receive commands from the primary digital lighting controller in association with the address of the sub-network lighting controller. The sub-network lighting controller is also configured to control the plurality of secondary lighting fixtures based on the commands received from the primary digital lighting controller.

In another example embodiment, a method for controlling a sub-network and monitoring of lighting fixtures includes manually setting an address of a sub-network lighting controller using a switch bank of the sub-network lighting controller and installing the sub-network lighting controller on a primary lighting network. The method also includes assigning, by the sub-network lighting controller, addresses to a plurality of secondary lighting fixtures on a secondary lighting network of the sub-network lighting controller. The sub-network lighting controller receives commands from a primary digital lighting controller on the primary lighting network and controls the plurality of secondary lighting fixtures based on the received commands from the primary digital lighting controller. The sub-network lighting controller also receives sub-network information from the secondary lighting fixtures.

These and other aspects, objects, features, and embodiments will be apparent from the following description and the appended claims.

DETAILED DESCRIPTION OF THE EXAMPLE EMBODIMENTS

In the following paragraphs, particular embodiments will be described in further detail by way of example with reference to the figures. In the description, well known components, methods, and/or processing techniques are omitted or briefly described. Furthermore, reference to various feature(s) of the embodiments is not to suggest that all embodiments must include the referenced feature(s).

Turning now to the drawings, in which like numerals indicate like elements throughout, example embodiments are described in detail. FIG. **1** presents a system illustrating an example operating environment for an example DALI network lighting control system according to one example embodiment. Referring now to FIG. **1**, the system **10** includes a Digital Addressable Lighting Interface (DALI) controller **110** (which is also referred to as a digital lighting controller in this specification), an administrator terminal **120** communicably coupled to the DALI controller **110** via network **130**, and multiple lighting fixtures **141-148** communicably coupled to a lighting network **132**. The DALI controller **110** may include an SCMD6400 or other similar DALI controller as understood in the art. The DALI controller **110** controls the lighting fixtures **141-148** using control signals and/or messages transmitted via the lighting network **132**. It is noted that, in certain example embodiments, each of the lighting fixtures **141-148** can be independently coupled to a power source and that the lighting network **132** provides control signals and not power to the lighting fixtures **141-148**.

In certain example embodiments, the DALI controller **110** controls and monitors each of the lighting fixtures **141-148** via the lighting network **132** using unique addresses assigned to each of the lighting fixtures **141-148**. In one example embodiment, the unique addresses may be assigned by the DALI controller **110** during initialization or configuration of the system **10**. For example, during the initialization or configuration of the system **10**, each of the lighting fixtures **141-148** is assigned both an individual address uniquely identifying the lighting element and a group address shared with other lighting elements. As such, each of the lighting fixtures **141-148** may be controlled by the DALI controller **110** with reference to its unique individual or group address.

As one example, each lighting fixture **141-148** may be assigned a unique individual static address in a range from **0** to **63**. As such, the lighting network **132** may include up to sixty-four lighting elements that are individually addressable by the DALI controller **110**. Fewer than sixty-four lighting elements may also be coupled to the lighting network **132** in various embodiments. In certain example embodiments, the lighting network **132** may include a single pair of wires that forms a communications bus to the lighting fixtures **141-148** on the network **132** and be connected to the lighting elements **141-148** in various topologies. The pair of wires may be connected to a ballast of each of the lighting fixtures **141-148**, where each ballast controls the operation (i.e., "on" or "off" or output power) of a respective one of the fixtures **141-148**.

The administrator terminal **120** may be used to update settings and control parameters on the DALI controller **110**, so that the DALI controller **110** may control and operate the lighting fixtures **141-148** based on predetermined and predefined lighting modes. For example, using flexible software and/or firmware configurations, the DALI controller **110** may organize the lighting fixtures **141-148** into one or more groups of lighting fixtures and control groups of the lighting fixtures **141-148**, or control each of the lighting fixtures **141-148** individually. Additionally, one or more switches may be coupled to the lighting network **132**, and the DALI controller **110** may control individual lighting fixtures or groups of lighting fixtures based on the settings of the switches. In certain example embodiments, the DALI controller **110** may also receive feedback from each of the lighting fixtures **141-148** based on a query to the lighting fixtures. For example, the feedback may include an "on" or "off" status or failure condition information or data. Thus, the DALI controller **110** is able to receive feedback regarding lighting fixtures which may not be operating properly.

It is noted that setting up the system **10** during initialization or configuration may be time consuming. For example, determining particular locations of each of the plurality of lighting fixtures **141-148** during set up of the system **10** may be especially time consuming if the DALI controller **110** assigns the unique individual addresses of the lighting elements **141-148** randomly. In other words, it may be difficult for a technician to put together groups of the lighting fixtures **141-148**, if the addresses of the lighting elements **141-148** are unknown when they are installed. Additionally, the DALI controller **110** may be limited to controlling and/or uniquely addressing a limited number of lighting fixtures over the lighting network **132**. As described in the example above, the DALI controller **110** may only be able to uniquely identify and address up to sixty-four lighting fixtures. Thus, it may become necessary to install several DALI controllers when installations requiring greater than sixty-four lighting fixtures are required.

FIG. **2** presents a system illustrating an example operating environment for an example digital sub-network lighting system **20** in an example DALI lighting control network system according to one example embodiment. Referring now to FIGS. **1** and **2**, the example sub-network system **20** will be compared to the example system **10** of FIG. **1**. As compared to system **10**, the system **20** includes DALI sub-network interface units **250** and **260**, which are also referred to as sub-network lighting controllers in this specification. In certain example embodiments, the system **20** includes an administrative terminal **220**, a network **230**, a primary DALI controller **210** (which is also referred to as a digital lighting controller in this specification), a plurality of primary lighting fixtures **241-244** communicably coupled to a primary lighting network **232**, and the DALI sub-network interface units **250** and **260**. The lighting network **232** may include a single pair of wires that forms a communications bus to the primary lighting fixtures **241-244** and to the DALI sub-network interface units **250** and **260**. Each of the DALI sub-network interface units **250** and **260** is communicably coupled to secondary lighting networks **272** and **282**, respectively. The DALI sub-network interface unit **250** is communicably coupled to the secondary lighting network **272**. Secondary lighting fixtures **251-254** are also communicably coupled to the secondary lighting network **272**. Similarly, the DALI sub-network interface unit **260** is communicably coupled to secondary lighting network **282**, and the secondary lighting fixtures **261-264** are communicably coupled to the secondary lighting network **282**. Each of the secondary lighting networks **272** and **282** may support several secondary lighting fixtures, such as 16 lighting fixtures, for example.

The DALI sub-network interface units **250** and **260** assign addresses to the respective plurality of secondary lighting fixtures **251-254** and **261-264** on the respective secondary lighting network **272**, **282**. The DALI sub-network interface

units **250** and **260** may assign unique individual and group addresses to the secondary lighting fixtures **251-254** and **261-264**, respectively.

The DALI sub-network interface unit **250** assigns addresses to the plurality of secondary lighting fixtures **251-254** on the secondary lighting network **272**. For example, the DALI sub-network interface unit **250** may assign a unique individual address and a group address to each lighting fixture coupled to the secondary network **272**. A unique individual address is assigned to an individual lighting fixture of the plurality of secondary lighting fixtures **251-254**, and the group address is assigned to two or more lighting fixtures of the plurality of secondary lighting fixtures **251-254**. The DALI sub-network interface unit **250** also receives one or more commands from the primary DALI controller **210**. The one or more commands from the primary DALI controller **210** are sent to the DALI sub-network interface unit **250** in association with an address of the DALI sub-network interface unit **250** on the primary network **232**. The DALI sub-network interface unit **250** also transmits sub-network information to the primary DALI controller **210** in association with an address of the DALI sub-network interface unit **250** on the primary network **232**. The address of the DALI sub-network interface unit **250** on the primary lighting network **232** may be manually set at the DALI sub-network interface unit **250**. For example, a user (e.g., a technician) may manually set the address of the DALI sub-network interface unit **250** using a switch bank (e.g., one or more Dual In-line Package (DIP) switches) included in or attached to the DALI sub-network interface unit **250** by physically changing a switch position of one or more switches of the switch bank. In certain example embodiments, the DALI sub-network interface unit **250** controls the plurality of secondary lighting fixtures **251-254** based on the one or more commands received from the primary DALI controller **210** via the primary lighting network **232**. In certain example embodiments, the DALI sub-network interface unit **250** may itself be re-initialized by a command from the primary DALI controller **210**.

In certain example embodiments, the DALI sub-network interface unit **260** assigns addresses to the plurality of secondary lighting fixtures **261-264** on the secondary lighting network **282**. For example, the DALI sub-network interface unit **260** assigns a unique individual address and a group address to each lighting fixture coupled to the secondary network **282**. The DALI sub-network interface unit **260** also receives one or more commands from the primary DALI controller **210** associated with an address of the DALI sub-network interface unit **260** on the primary network **232**. Similar to the DALI sub-network interface unit **250**, the DALI sub-network interface unit **260** also transmits sub-network information to the primary DALI controller **210** in association with the address of the DALI sub-network interface unit **260** on the primary network **232**. In certain example embodiments, the DALI sub-network interface unit **260** controls the plurality of secondary lighting fixtures **261-264** based on the one or more commands received from the primary DALI controller **210** via the primary lighting network **232**. In certain example embodiments, the DALI sub-network interface unit **260** may itself be re-initialized by a command from the primary DALI controller **210**.

In certain example embodiments, the DALI sub-network interface units **250** and **260** receive information, such as status information and failure condition information, from the secondary lighting fixtures **251-254** and **261-264** via the secondary lighting networks **272** and **282**, respectively, and relay the information to the primary DALI controller **210** via the primary lighting network **232**.

In certain example embodiments, the DALI sub-network interface units **250** and **260** detect when a new ballast or a secondary lighting fixture has been attached to its respective secondary network. For example, once the DALI sub-network interface units **250** and **260** are coupled to the primary lighting network **232**, each of the DALI sub-network interface units **250** and **260** may detect addition of a ballast or a secondary lighting fixture to the respective secondary lighting networks **272** and **282**. Upon detecting that a new ballast or secondary lighting fixtures has been attached to its secondary network **272**, the DALI sub-network interface unit **250** can automatically initialize the new ballast or secondary lighting fixture, and provide the new fixture with a new unique individual address and/or group address. Similarly, upon detecting that a new ballast or a secondary lighting fixture has been attached to its secondary network **282**, the DALI sub-network interface unit **260** can automatically initialize the new ballast or secondary lighting fixture, and provide the new fixture with a new unique individual address and/or a group address.

In certain example embodiments, the sub-network **272** includes a sensor **251** as one of the lighting fixtures **251-254**. In other words, as noted above, lighting fixtures may include elements other than lights or luminaries. For example, lighting fixtures may include sensors, switches, control panels, and other devices. According to certain example embodiments, the sensor **251** can be a motion sensor, photo sensor, passive infrared sensor or other similar sensor device. In connection with the sensor **251**, the DALI sub-network interface unit **250** is further able to control one or more of the lighting fixtures on the secondary network **272** based on feedback signals provided by the sensor **251**. For example, the DALI sub-network interface unit **250** may turn all of the lighting fixtures **252-254** on, off, or set all of the lighting fixtures **252-254** to any attainable level between on and off based on feedback information gathered using the sensor **251**. The logic to provide control of lighting fixtures based on a feedback signal from a sensor would usually be embodied within the Primary DALI Controller **210**, another device on Network **230**, or within the administrative terminal **220**. However, in the sub-network system **20**, the DALI sub-network interface unit **250** may not require any instruction or command from the primary DALI controller **210** to control lighting fixtures on the secondary network **272**. That is, the DALI sub-network interface unit **250** may create an independent DALI network of devices.

In the example system **20**, the primary DALI controller **210** may uniquely address and communicate with each of the primary lighting fixtures **241-244** and the DALI sub-network interface units **250** and **260** via the primary lighting network **232**. However, the primary DALI controller **210** may not uniquely address and communicate with any of the secondary lighting fixtures **251-254** and **261-264**. That is, in certain example embodiments, the secondary lighting fixtures **251-254** and **261-264** are only separately addressable by one of the DALI sub-network interface units **250** and **260**. It is noted that, in this example embodiment, to the primary DALI controller **210**, the DALI sub-network interface units **250** and **260** appear to be standard DALI lighting fixtures having unique and group addresses. Thus, to control the secondary lighting fixtures **251-254** and **261-264**, the primary DALI controller **210** may address a command to one of the DALI sub-network interface units **250** and **260**. In turn, the DALI sub-network interface units **250** and **260** pass commands received from the primary DALI controller **210** to the respective secondary

lighting fixtures **251-254** and **261-264**. In this manner, the number of lighting fixtures controlled via the primary lighting network **232** by the primary DALI controller **210** is increased beyond sixty-four, although the secondary lighting fixtures **251-254** and **261-264** may not be addressed separately.

According to other aspects of the example system **20**, although the secondary lighting fixtures **251-254** and **261-264** may not be addressed separately by the primary DALI controller **210**, failure data or other information from a secondary lighting fixtures may still be communicated to the primary DALI controller **210** in association with an address assigned to a secondary DALI sub-network interface unit supporting the lighting fixtures. Thus, the primary DALI controller **210** may identify a failure of one of the secondary lighting fixtures **251-254** associated with the address of the DALI sub-network interface unit **250**. Similarly, the primary DALI controller **210** may identify a failure of one of the secondary lighting fixtures **261-264** associated with the address of the DALI sub-network interface unit **260**. In other words, the primary DALI controller **210** may associate a failure of one of the secondary lighting fixtures **251-254** and **261-264** with a failure on one of the sub-networks **272** and **282**, even if it is unable to determine an actual address of the specific lighting fixture that has had a failure.

By using the DALI sub-network interface units **250** and **260**, the number of lighting fixtures in the example sub-network system **20** can be extended in excess of the number of the plurality of primary lighting fixtures directly attached to the lighting network **232** without requiring another primary DALI controller. Further, by setting particular addresses of the DALI sub-network interface units **250** and **260** by a user (e.g., a technician) at or before installation time, the DALI sub-network interface units **250** and **260** can be associated with the particular addresses on the lighting network **232**. During operation of the sub-network system **20**, because the addresses of the DALI sub-network interface units **250** and **260** are known at installation, information conveyed to a user (e.g., a technician) by the primary DALI controller **210** with respect to an address of either one of the DALI sub-network interface units **250** and **260** can be easily identified as corresponding to the respective DALI sub-network interface unit **250** or **260**. Further, because each one of the DALI sub-network interface units **250** and **260** controls a respective group of secondary lighting fixtures **251-254** or **261-264**, information provided by the primary DALI controller **210** to the user about either one of the DALI sub-network interface units **250** or **260** can be identified as corresponding to the respective group of secondary lighting fixtures **251-254** or **261-264**.

Although FIG. **2** shows a single sensor **251** attached to the sub-network **272**, in alternative embodiments, more than one sensor may be attached to the sub-network **272**. Further, in alternative embodiments, fewer than three lighting fixtures may be attached to the sub-network **272**. Although two DALI sub-network interface units are shown in FIG. **3**, in alternative embodiments, fewer than two or more than two DALI sub-network interface units may be attached to the primary network **232**.

FIG. **3** is a schematic diagram of the example DALI sub-network interface unit **250** according to one example embodiment. Referring now to FIG. **3**, the example DALI sub-network interface unit **250** includes a processor **310**, a power supply **320**, a sub-net port **330**, a DALI port **340**, a firmware update port **370**, and switch banks **350** and **360**. In certain example embodiments, the processor **310** controls the overall operation of the DALI sub-network interface unit **250** and communicates with a primary DALI controller, such as the primary DALI controller **210**, via the DALI port **340**. The processor **310** also communicates with secondary lighting fixtures, such as the secondary lighting fixtures **251-254**, on a secondary network, such as the secondary network **272**, via the sub-net port **330**. For example, the processor **310** may control the secondary lighting fixtures based on a feedback signal received from a sensor (e.g., the sensor **251**) attached to the secondary lighting network. To illustrate, the processor **310** may turn the secondary lighting fixtures on, off, or to a level between on and off based on information received from the sensor.

In certain example embodiments, the processor **310** may detect a new lighting fixture attached on the secondary lighting network. In response to detecting that a new lighting fixture is attached on the secondary lighting network, the processor **310** may assign a unique individual address to the new lighting fixture.

In certain example embodiments, the sub-net port **330** is a digital lighting interface port that includes circuitry and other logic necessary for encoding and decoding data messages communicated via a secondary lighting network. The example DALI port **340** is a digital lighting interface port that includes circuitry and other logic necessary for communicating with a primary DALI controller over a primary lighting network.

In certain example embodiments, the power supply **320** includes circuitry and other logic to provide power to each element of the DALI sub-network interface unit **250**. Generally, the power supply **320** is provided with a line voltage and converts the line voltage to an appropriate direct current voltage for the lighting fixtures controllable by the DALI sub-network interface unit **250**. In one example embodiment, the line voltage provided to the power supply **320** is 230 VAC 50/60 Hz but other voltage versions can be made available. In one example embodiment, the firmware update port **370** includes circuitry and other logic necessary for updating the firmware and/or software executed by the processor **310**. The firmware update port **370** may also include a memory device to store the firmware and/or software that is executed by the processor **310**. In one example embodiment, the example switch bank **350** includes a plurality of Dual In-line Package (DIP) switches to manually set unique individual and group addresses of the DALI sub-network interface unit **250** on a primary lighting network. In certain example embodiments, the switch bank **360** may include multiple DIP switches for setting up the sub-net port **330**.

Using the switch bank **350**, a technician may set the unique and group addresses of the DALI sub-network interface **250** on a primary lighting network before installation of the sub-network interface unit **250** on the primary lighting network. For example, a technician may physically set the address of the DALI sub-network interface unit **250** by physically changing a position of one or more switches of the switch bank **350**. Thus, after setting the addresses of the DALI sub-network interface unit **250**, a primary DALI controller may uniquely identify the DALI sub-network interface unit **250** without any requirement to assign addresses to the DALI sub-network interface unit **250**. This aspect of the DALI sub-network interface unit **250** may help to save time during installation and configuration of lighting systems incorporating the DALI sub-network interface unit **250**. Further, using the DALI sub-network interface **250**, a primary lighting network may be extended to include more than sixty-four lighting fixtures.

With reference again to FIG. **2** for a further description of the operation of the system **20**, if the primary DALI controller **210** communicates a "turn on" command to the DALI sub-

network interface unit **250**, the DALI sub-network interface unit **250** sends associated commands to all of the secondary lighting fixtures **252-254** on its secondary lighting network **272**. In one example embodiment, for example, the DALI sub-network interface unit **250** forwards commands received from the primary DALI controller **210** to all of the secondary lighting fixtures **252-254** on its secondary lighting network **272**. In this context, the DALI sub-network interface unit **250** appears to the primary DALI controller **210** as a generic lighting fixture or luminaire on the primary lighting network **232**, such as any one of the lighting fixtures **241-244**. Because the example DALI sub-network interface unit **250** receives information and data including failure codes from the fixtures **251-254** communicably coupled to the secondary lighting network **272**, the DALI sub-network interface unit **250** is able to relay such failure or other data to the primary DALI controller **210** in association with its uniquely assigned address set by the switch bank **350**, so that the primary DALI controller **210** may identify the failure as being on the secondary lighting network **272**.

In turn, the primary DALI controller **210** is able to indicate to a user that a failure has occurred on the secondary lighting network **272** based on the failure data relayed to the primary DALI controller **210** by the DALI sub-network interface unit **250** in association with its uniquely assigned address. In this case, although the primary DALI controller **210** may not be able to uniquely identify to the user which specific lighting fixture **251-254** on the secondary lighting network **272** has failed, the user is at least able to determine that the failure is on the secondary network **272**.

Although FIG. **3** illustrates two switch banks **350** and **360**, in alternative embodiments, the DALI sub-network interface unit **250** may include fewer or more than two switch banks Further, two or more of the individual components of the DALI sub-network interface unit **250**, such as the subnet port **330**, the DALI port **340**, and the firmware update port **370**, although shown in FIG. **3** as separate elements, may be combined into fewer number of elements. Further, in some embodiments, the DALI sub-network interface unit **250** may include a standalone memory device outside of the firmware update port **370** to store code and/or data related to, for example, operations of the processor **310**.

FIG. **4** presents a flowchart of an example method **400** for the operation of a sub-network lighting system according to one example embodiment. Now referring to FIGS. **2-4**, the example method **400** is described in connection with the elements of system **20**. At step **410**, an address of a sub-network interface unit, such as the DALI sub-network interface unit **250**, is set. For example, the address of the sub-network interface unit may be manually set using a switch bank located at the sub-network interface unit. Both unique individual and group addresses may be manually set at step **410** using the bank of DIP switches, for example. At step **420**, the DALI sub-network interface unit **250** is installed. Installation of the DALI sub-network interface unit **250** at step **420** may include connecting the DALI sub-network interface unit **250** to power, to a primary lighting network, and to a secondary lighting network, as described above. Installation may also include the installation of secondary lighting elements on the secondary lighting network, as necessary. After installation at step **420**, the DALI sub-network interface unit **250** assigns addresses to the secondary lighting fixtures, such as the secondary lighting fixtures **251-254**, on the secondary lighting network at step **430**. That is, the DALI sub-network interface unit **250** may assign unique and group addresses to the secondary lighting fixtures **251-254**.

At step **440**, the DALI sub-network interface unit **250** receives one or more commands from a primary DALI controller, such as the primary DALI controller **210**, over the primary lighting network. In turn, the DALI sub-network interface unit **250** controls the secondary lighting fixtures **251-254** on the secondary lighting network based on the commands received from the primary DALI controller **210** at step **450**. For example, the DALI sub-network interface unit **250** may turn on, off, or set to a level between on and off based on the commands received from the primary DALI controller **210**. In addition to receiving commands from the primary DALI controller **210** over the primary lighting network, in certain example embodiments, the DALI sub-network interface unit **250** also receives information from the secondary lighting fixtures **251-254** over the secondary lighting network at step **460**.

As described above, the information received from the secondary lighting fixtures **251-254** may include status or failure information or data. After receiving information from the secondary lighting fixtures **251-254** at step **460**, the DALI sub-network interface unit **250** relays the information to the primary DALI controller **210** at step **470**, in association with the address of the DALI sub-network interface unit **250** set in step **410**.

Although particular embodiments have been described herein in detail, the descriptions are by way of example. The features of the embodiments described herein are representative and, in alternative embodiments, certain features, elements, and/or steps may be added or omitted. Additionally, modifications to aspects of the embodiments described herein may be made by those skilled in the art without departing from the spirit and scope of the following claims, the scope of which are to be accorded the broadest interpretation so as to encompass modifications and equivalent structures.

What is claimed is:

1. A digital sub-network interface unit, comprising:

a primary digital lighting interface port to couple to a primary lighting network, wherein an address of the digital sub-network interface unit on the primary lighting network is manually set at the digital sub-network interface unit;

a secondary digital lighting interface port to couple to a secondary lighting network; and

a lighting sub-network processor configured to:

assign addresses to a plurality of secondary lighting fixtures,

receive commands from a primary digital lighting controller in association with the address of the digital sub-network interface unit, and

control the plurality of secondary lighting fixtures based on the commands received from the primary digital lighting controller.

2. The digital sub-network interface unit of claim **1**, wherein the lighting sub-network processor is configured to relay sub-network information to the primary digital lighting controller and wherein the lighting sub-network processor is configured to relay the sub-network information in association with the address of the digital sub-network interface unit.

3. The digital sub-network interface unit of claim **2**, wherein the sub-network information comprises one or more failure codes from at least one lighting fixture of the plurality of secondary lighting fixtures.

4. The digital sub-network interface unit of claim **2**, further comprising a firmware update port to receive firmware updates to a firmware executable by the lighting sub-network processor.

5. The digital sub-network interface unit of claim 1, wherein the addresses include unique individual addresses and a group address, wherein each of the unique individual addresses is assigned to a respective lighting fixture of the plurality of secondary lighting fixtures, and wherein the group address is assigned to two or more lighting fixtures of the plurality of secondary lighting fixtures.

6. The digital sub-network interface unit of claim 1, wherein the lighting sub-network processor is configured to control the plurality of secondary lighting fixtures based on a feedback signal received from a sensor attached to the secondary lighting network.

7. The digital sub-network interface unit of claim 1, wherein the lighting sub-network processor is configured to turn the plurality of secondary lighting fixtures on, off, or to a level between on and off based on information received from a sensor.

8. The digital sub-network interface unit of claim 1, further comprising a switch bank for manually setting the address of the digital sub-network interface unit.

9. The digital sub-network interface unit of claim 1, wherein the lighting sub-network processor is further configured to detect a new lighting fixture attached to the secondary lighting network.

10. The digital sub-network interface unit of claim 9, wherein the lighting sub-network processor is further configured to assign a unique individual address to the new lighting fixture in response to detecting that the new lighting fixture is attached to the secondary lighting network.

11. A digital sub-network lighting system, comprising:

a plurality of primary lighting fixtures communicably coupled to a primary lighting network;

a primary digital lighting controller communicably coupled to the plurality of primary lighting fixtures and configured to assign addresses to the plurality of primary lighting fixtures; and

a sub-network lighting controller communicably coupled to the primary lighting network and to a secondary lighting network, wherein an address of the sub-network lighting controller on the primary lighting network is manually set at the sub-network lighting controller, the sub-network lighting controller configured to:

assign addresses to a plurality of secondary lighting fixtures coupled to the secondary lighting network,

receive commands from the primary digital lighting controller in association with the address of the sub-network lighting controller, and

control the plurality of secondary lighting fixtures based on the commands received from the primary digital lighting controller.

12. The digital sub-network lighting system of claim 11, wherein the sub-network lighting controller is configured to relay sub-network information received from the plurality of secondary lighting fixtures to the primary digital lighting controller and wherein the sub-network lighting controller is configured to relay the sub-network information in association with the address of the sub-network lighting controller on the primary lighting network.

13. The digital sub-network lighting system of claim 12, wherein the sub-network information comprises status information from at least one lighting fixture of the plurality of secondary lighting fixtures.

14. The digital sub-network lighting system of claim 11, wherein the sub-network lighting controller comprises a switch bank for manually setting the address of the sub-network lighting controller, the address of the sub-network lighting controller comprising an individual address of the sub-network lighting controller on the primary lighting network.

15. The digital sub-network lighting system of claim 11, further comprising a sensor attached to the secondary lighting network.

16. A method for monitoring and controlling lighting fixtures of a sub-network, the method comprising:

manually setting an address of a sub-network lighting controller using a switch bank of the sub-network lighting controller;

installing the sub-network lighting controller on a primary lighting network;

assigning, by the sub-network lighting controller, addresses to a plurality of secondary lighting fixtures on a secondary lighting network;

receiving, by the sub-network lighting controller, commands from a primary digital lighting controller coupled to the primary lighting network;

controlling, by the sub-network lighting controller, the plurality of secondary lighting fixtures based on the commands received from the primary digital lighting controller; and

receiving, by the sub-network lighting controller, sub-network information from the secondary lighting fixtures.

17. The method of claim 16, further comprising relaying, by the sub-network lighting controller, the sub-network information received from the secondary lighting fixtures to the primary digital lighting controller in association with the address of the sub-network lighting controller.

18. The method of claim 16, further comprising connecting the plurality of secondary lighting fixtures to the sub-network.

19. The method of claim 16, further comprising controlling, by the sub-network lighting controller, the plurality of secondary lighting fixtures based on feedback information received from a sensor attached to the secondary lighting network.

20. The method of claim 16, further comprising detecting a new lighting fixture attached to the secondary lighting network.

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